DESIGN AND PERFORMANCE OF THE LLRF SYSTEM FOR THE NOvA UPGRADE TO THE FERMILAB RECYCLER AND MAIN INJECTOR *

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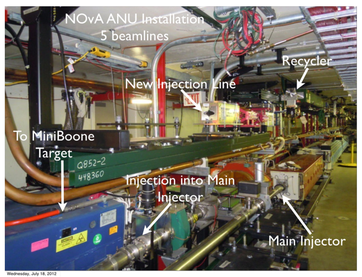
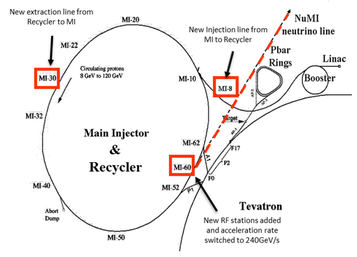
Accelerator Upgrades for NOvA

Proton source upgraded from 320kW to 700kW

- Recycler reconfigured as a slip stacking pre-injector
- MI will deliver 4.9×10^{12} protons per pulse
- Beam rep rate reduced from 2.2s to 1.33s
- This results in 6×10^{20} pot/yr.

Main Injector, Recycler Beamlines





LLRF Requirements

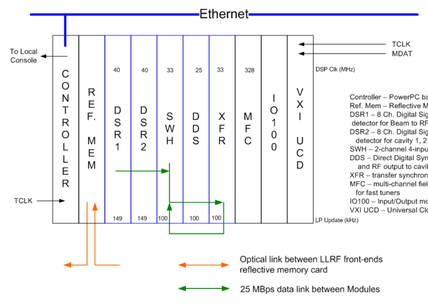
Main Injector

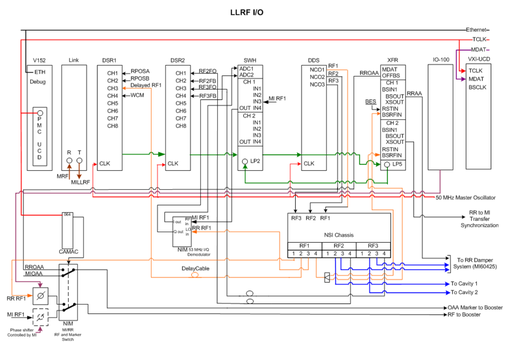
- Booster injection (Booster Beam to MI)
- Injections through MI8 Beamline
- Support for "SyncMItoBooster" and "SyncBoosterToMI" Functions
- Transfer Slip-Stacked beam from RR to MI
- Transfer beam (not slip stacked) from RR to MI
- MI will continue to frequency lock to RR
- Booster will get its marker and frequency/phase reference from MILLRF or RRLLRF
- Frequency jump on transfer from RR to MI

Recycler

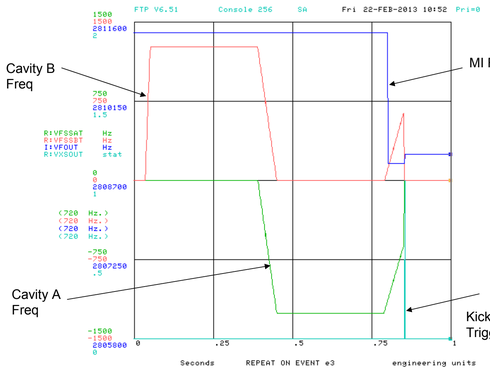
- Independent RF control for two cavities
- Slip stacking Booster protons in the RR
- Booster protons in the Recycler w/o SS
- Booster injection only
- SyncRRtoBooster and SyncBoosterToRR
- Frequency control for aperture scans +-2kHz
- Diagnostics
  - Beam to RF phase detector
  - Radial position monitor

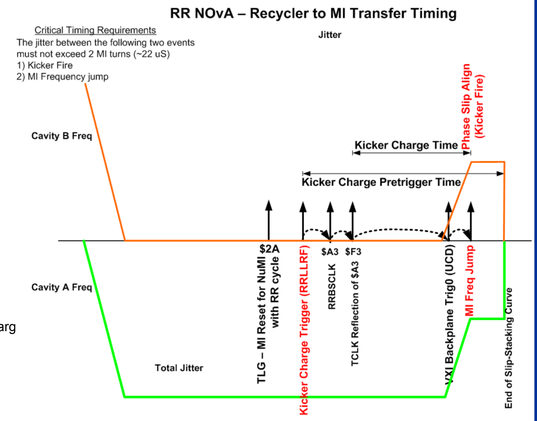
Recycler LLRF System



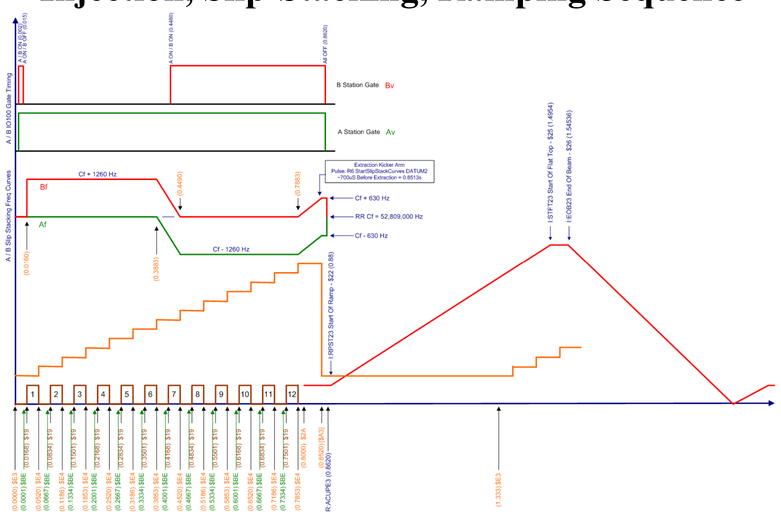


Slip Stacking

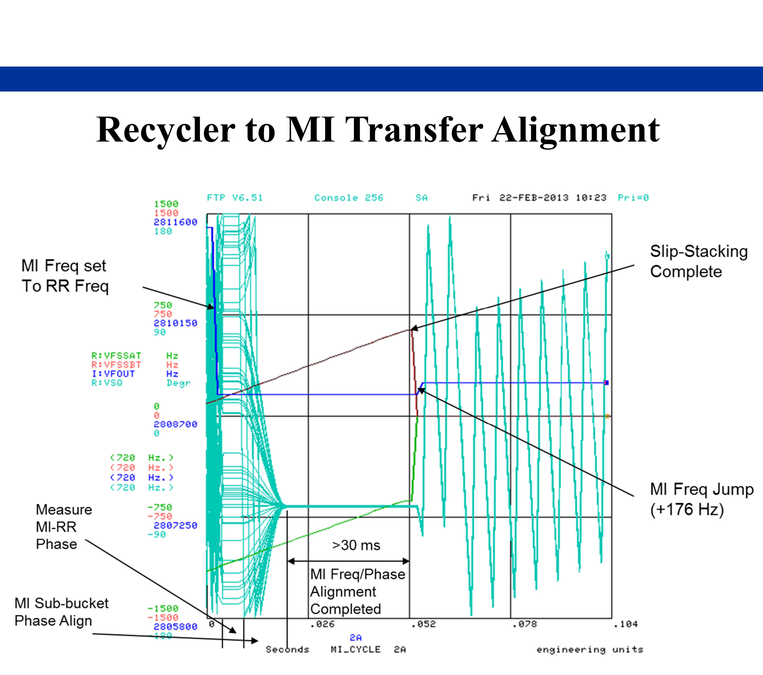


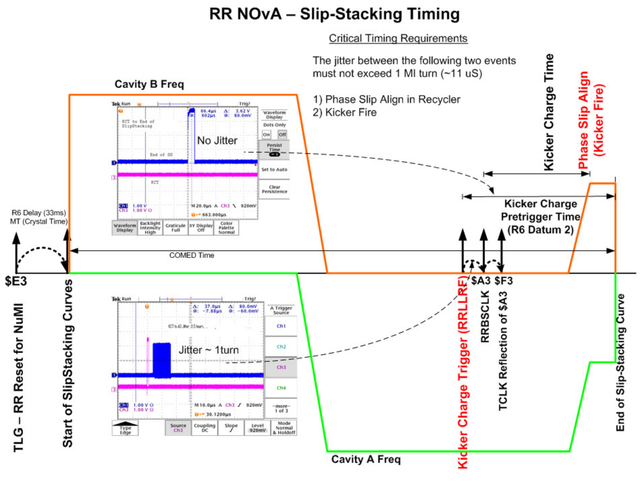


Injection, Slip-Stacking, Ramping Sequence

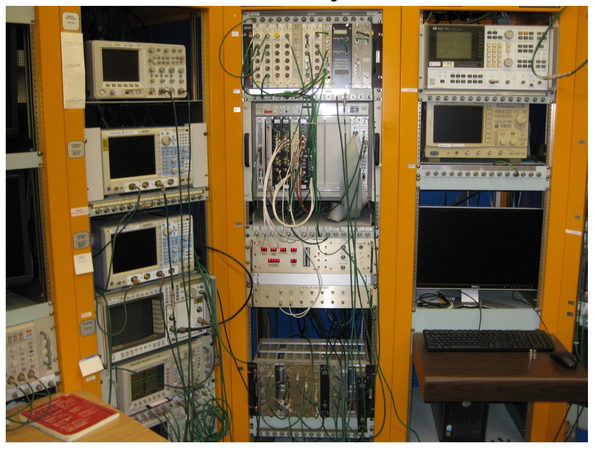


Recycler to MI Transfer Alignment





LLRF System



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